Attachment 2
IB-OFA-2002-03
3/1/2002

Program for Climate, Ecosystem and Fire Applications

Development of Lightning Climatology Information over the Western U.S.

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CEFA-01-03

October 2001

Attachment 2

Forward

This report describes the lightning climatology products for the western United States developed using the National Lightning Detection Network™ lightning dataset. The project was done under Task Order 1422RAH012403 of the Cooperative Assistance Agreement No. 1422RAA000002 between the Bureau of Land Management National Office of Fire and Aviation and the Desert Research Institute Program for Climate, Ecosystem and Fire Applications. For further information regarding this report or project, please contact either:

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Project Objectives

From 1990 and 2000, our analyses of fire occurrence data indicates that between 50% and 75% of all fire starts in the western United States on Bureau of Land Management (BLM) land, depending upon the region, were caused by cloud-to-ground (CG) lightning strikes. Thus, it is desirable to have a better understanding of when and where these lightning strikes occur historically so that fire managers and planners can allocate their resources more effectively, and to provide a knowledge base for meteorologists and other users of climate information. Also, this information is necessary in analyzing climate factors related to seasonal fire activity (e.g., Brown and Hall 2000; 2001). Since 1989 the National Lightning Detection Network™ (NLDN) has been recording information about CG lightning strikes across the U.S. The objective of this project was to develop CG lightning strike climatologies over the continental western U.S. for various time periods, including the annual average, monthly average, and hourly by month average number of lightning strikes.

Data

Cloud-to-ground lightning strike data for the period 1990 through 2000 were obtained from the National Lightning Detection Network™ maintained by Global Atmospherics, Inc. (GAI). The data set used for the analysis consists of the date, time, latitude, and longitude of the strike. These data are proprietary and were purchased directly from GAI. For further information about NLDN, see Cummins et al. (1998).

Methods

Climatologies for each time period of interest (i.e., annual, monthly, hourly by month) were computed by dividing the total number of lightning strikes within a grid for the time period by the total number of years (11). The area along the U.S.-Canada border includes three years (1998 – 2000) comprising strike data from Canadian lightning sensors. Eleven years is a relatively short period of record for developing a climatology given the occurrence of decadal and longer climate regimes. Also, with such a short record it is possible that a single thunderstorm that produced an "unusually" large amount of lightning strikes could heavily influence the climatology.

A 0.5 degree spatial grid was used across the western U.S. for each climatological time period. This grid size is somewhat of an arbitrary choice, but it does resolve some coarse terrain features and allows for identifying coherent regions of lightning activity. Annual correction values for 1990-1998 were applied to each grid to improve the climatology counts. These values attempt to correct for known detection efficiency issues across the network during those years based on an algorithm recently developed at GAI (Cummins 2001). Though the correction values are based on annual number of strikes, it is believed that these values can also be applied to the monthly and diurnal climatologies. For the last step of the climatology development, the gridded values were contoured using a Cressman analysis scheme (Cressman 1959) in GrADS (http://grads.iges.org/grads). The 0.5 degree resolution combined with the contouring technique creates a smoothing effect which results in a more generalized, but presumably representative climatology of an area.

Products Developed

Several graphical displays of the lightning climatology were produced in this project. Specific products include:

- Individual plots of –
  - Annual climatology
  - Monthly climatologies (see Figures 1a, b)
  - Hourly-by-month climatologies (see Figures 2a-d)

- Animations of –
  - Monthly climatologies throughout a year
  - Hourly climatologies (diurnal cycle) for a month

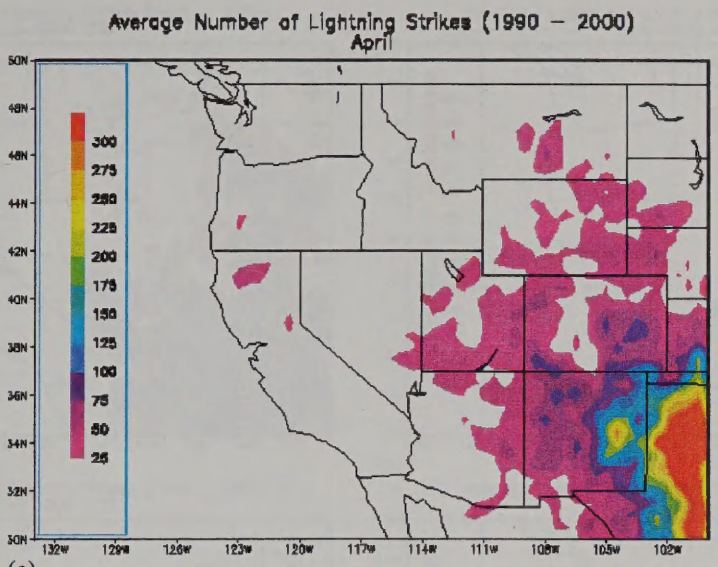
However, due to the proprietary nature of these data, access to the plots is currently limited to wildfire management agencies. Individuals or organizations interested in obtaining lightning data should contact GAI directly (http://www.glatmos.com).

Display options include the entire West, or four quadrant regions. On all plots color bars are provided to depict the contour interval. For example, in Figure 1a the intervals are 0-25 strikes, 26-50 strikes, etc. up to greater than 300 strikes. Note that the contour interval may change by month or by region to better highlight activity.

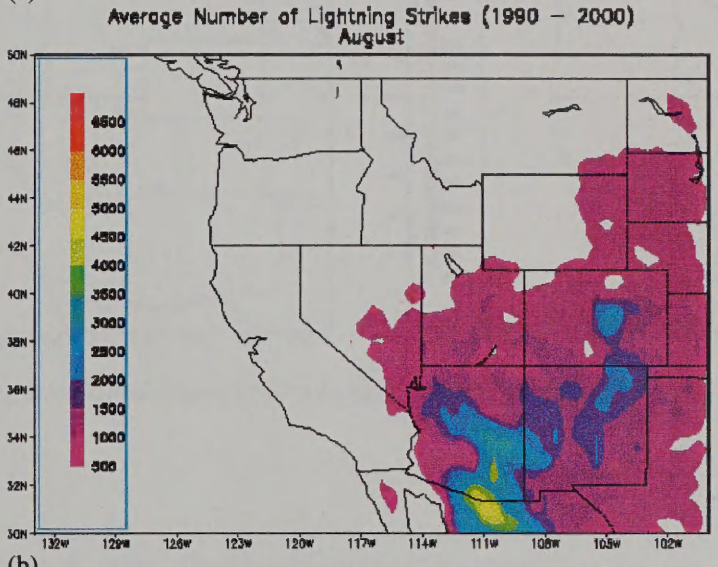
Figure 1 shows an example contoured plot of monthly NLDN lightning climatologies for a) April and b) August based upon the 1990-2000 period. Note the scale change in the contour intervals. For the month of April, the bulk of lightning activity occurs in Texas and western New Mexico. Figure 1b (August) shows that the largest amount of lightning activity occurs over Arizona, New Mexico and Colorado.

Figure 2 shows an example of NLDN hourly lightning climatologies in July for a) 00 UTC (4pm PST), b) 06 UTC (10pm PST), c) 12 UTC (4am PST) and d) 18 UTC (10am PST). In this example, increases in counts are shown at 00 UTC indicating the bulk of lightning activity occurring during the afternoon hours. On the CEFA web site, individual times may be selected, or the user can operate a Java player to animate through the 24-hour period for a given month.

Individual plots and animations for each climatological time period are available at the Desert Research Institute Program for Climate, Ecosystem and Fire Applications web site (http://www.cefa.dri.edu).



(a)



(b)

Figure 1: Monthly lightning strike climatology for (a) April and (b) August.

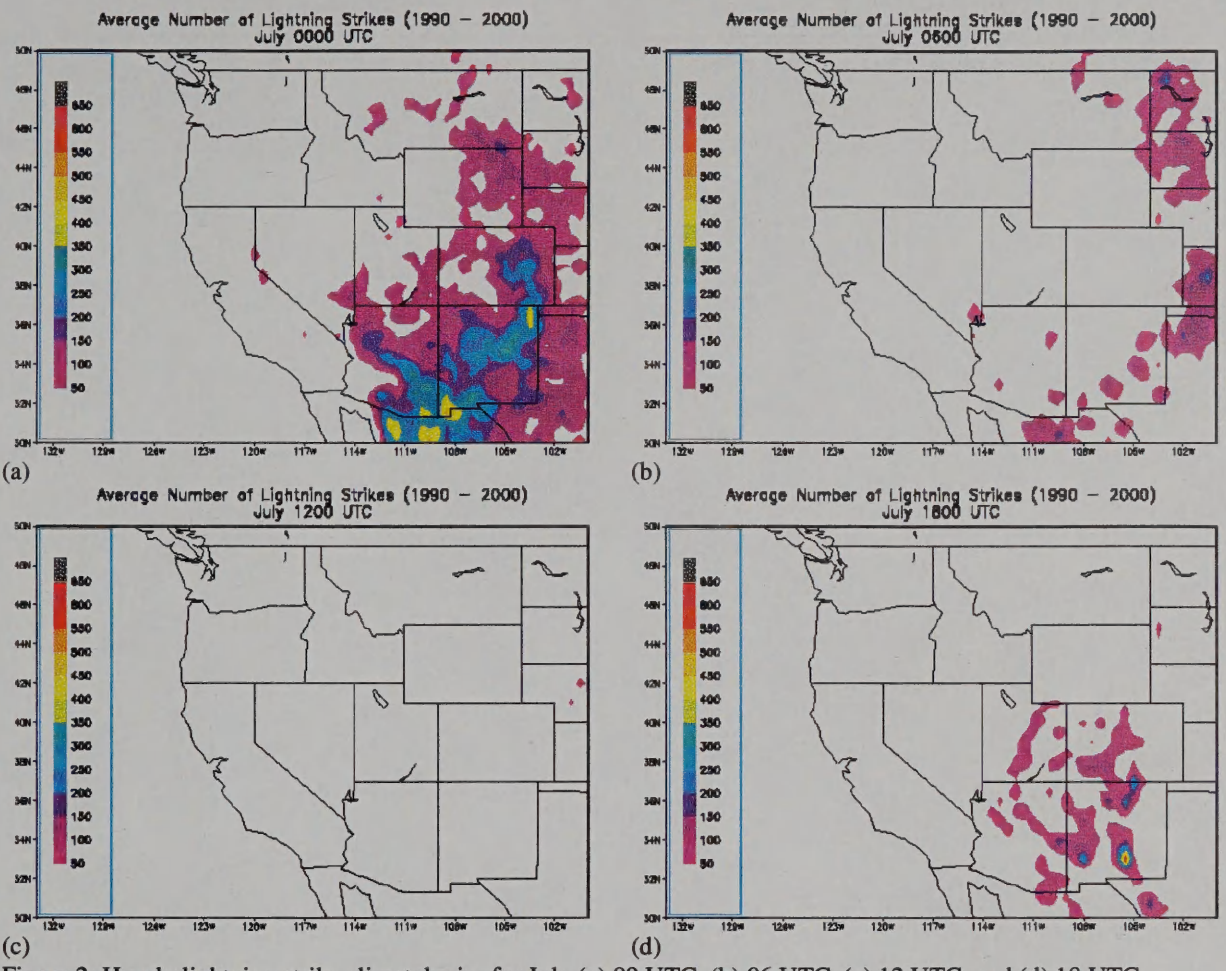


Figure 2: Hourly lightning strike climatologies for July (a) 00 UTC, (b) 06 UTC, (c) 12 UTC, and (d) 18 UTC.

References

Brown, T.J., and B.L. Hall, 2001: *Climate Analysis of the 2000 Fire Season.* CEFA Report 01-02, 37 pp. Available at http://www.dri.edu/CEFA/Publications/publications_index.htm

Brown, T.J., and B.L. Hall, 2000: *1999 Nevada Wildland Fire and Climate Season Assessment*, CEFA Report #00-04, 38 pp. Available at http://www.dri.edu/CEFA/Publications/publications_index.htm

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Cummins, K.L., 2001: *Personal communication*

Cummins, K.L., Martin J. Murphy, Edward A. Bardo, William L. Hiscox, Richard B. Pyle, Albert E. Pifer, 1998: A combined TOA/MDF technology upgrade of the U.S. National lightning detection network. *J. Geophys. Res.*, **103**, 9035-9044.

UNITED STATES DEPARTMENT OF THE INTERIOR

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March 01, 2002

In Reply Refer To:
9210 (FA-620) P

Information Bulletin No. OF&A 2002-035

To: State Directors
Attn: State Fire Management Officers

From: Director, Office of Fire and Aviation

Subject: 2001 Annual Report on BLM/Desert Research Institute Projects and Development of Lightning Climatology Information over the Western U.S.

In November, 2000, the BLM began a five-year cooperative Assistance Agreement with the Desert Research Institute's Program for Climate, Ecosystem and Fire Applications (CEFA) in Reno, Nevada. The scope of the Assistance Agreement is climate and ecosystem studies and product development for wildland fire and resource management.

In November, 2001, Climate, Ecosystem and Fire Applications produced its first Annual Report to the BLM, as required under the Assistance Agreement. A copy is enclosed for your review and use. The report describes work performed under the Assistance Agreement to date, including first year progress for each of the original seven Task Orders and other related activities. A review of the Climate, Ecosystem and Fire Applications program is also provided. The document is also available at http://cefa.dri.edu/Publications/publications_index.htm .

Also recently completed under the Assistance Agreement is Task 3: "Development of Lightning Climatology Information over the Western U.S." This project has created lightning climatology products using the National Lightning Detection Network™ lightning dataset. Specific products include individual plots of annual and monthly climatologies and animations of monthly and hourly climatologies (diurnal cycles). These products are described in more detail in Attachment 2 and can be accessed via the web at http://www.cefa.dri.edu./Cefa_Products/cefaprod_index.htm.

Questions regarding the Annual Report or "Development of Lightning Climatology Information over the Western U.S." can be directed to Paul Schlobohm, Program Manager, 775-674-7170, or Dr. Tim Brown, CEFA Director, 775-674-7090.

TIMOTHY M. MURPHY

Checked enclosure in library

2 - Attachments
1 - Annual Report (15 pp.)
2 - Development of Lightning Climatology Information over the Western U.S. (5 pp.)

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